MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

PCG0245 – CELLULAR REPRODUCTION AND GENETICS

(Foundation in Life Sciences)

13 MARCH 2019
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question paper consists of **8** printed pages excluding the cover page with **5** structured questions.
2. Answer **ALL** questions.
3. Distribution of marks for each section/question is given.

STRUCTURED QUESTIONS [50 MARKS]

Instructions: Answer all questions. Write your answers in the answer booklet.

Question 1 (10 marks)

a. A student cut thin sections of a root tip of *Allium cepa* and stained them to show its chromosomes. A photomicrograph of part of one of these sections is shown in **Figure 1**. Some cells are labeled **A**, **B**, **C**, **D** and **E**.

i. Which labeled cell is going through:
- Metaphase?
- Telophase?
- Anaphase? (1½ marks)

ii. Explain why the growth of roots involves mitosis. (2½ marks)

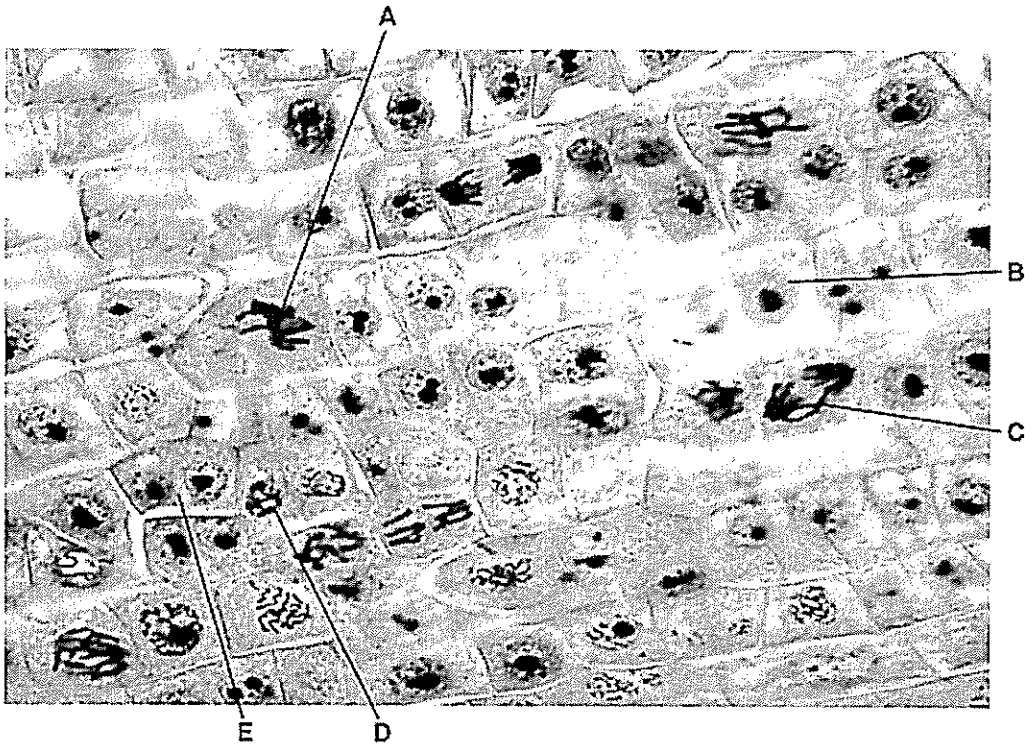

Figure 1

Continued...

b. Hemophilia is a sex-linked disease. In a family, the father is a normal male while the mother is a hemophiliac female.
   i. What is the probability that the offspring will inherit hemophilia? Draw the Punnett square to represent your answer. (2 marks)
   ii. Is it possible for a son to inherit an allele on an X chromosome from his father? Explain your answer. (1 mark)

c. A homozygous black male mouse is mated with a homozygous white female mouse. Allele B for black fur is dominant and the allele b for white fur is recessive. Draw a genetic diagram to determine the phenotypic percentage of the offspring produced from this mating. (2 marks)

d. Briefly explain Mendel's law of segregation. (1 mark)

Question 2 (10 marks)

a. **Figure 2** shows a cell that goes through a type of mutation during meiosis.
   i. What is the phenomenon that causes the mutation shown in **Figure 2**? (½ mark)
   ii. Determine the stage of cell division where this mutation occur. (½ mark)
   iii. Name the syndrome which results from the fertilization between a female gamete which has an extra X chromosome and a normal male gamete with a Y chromosome. (½ mark)
   iv. Give three physical characteristics of an individual who has the syndrome in (a)(iii). (1½ marks)

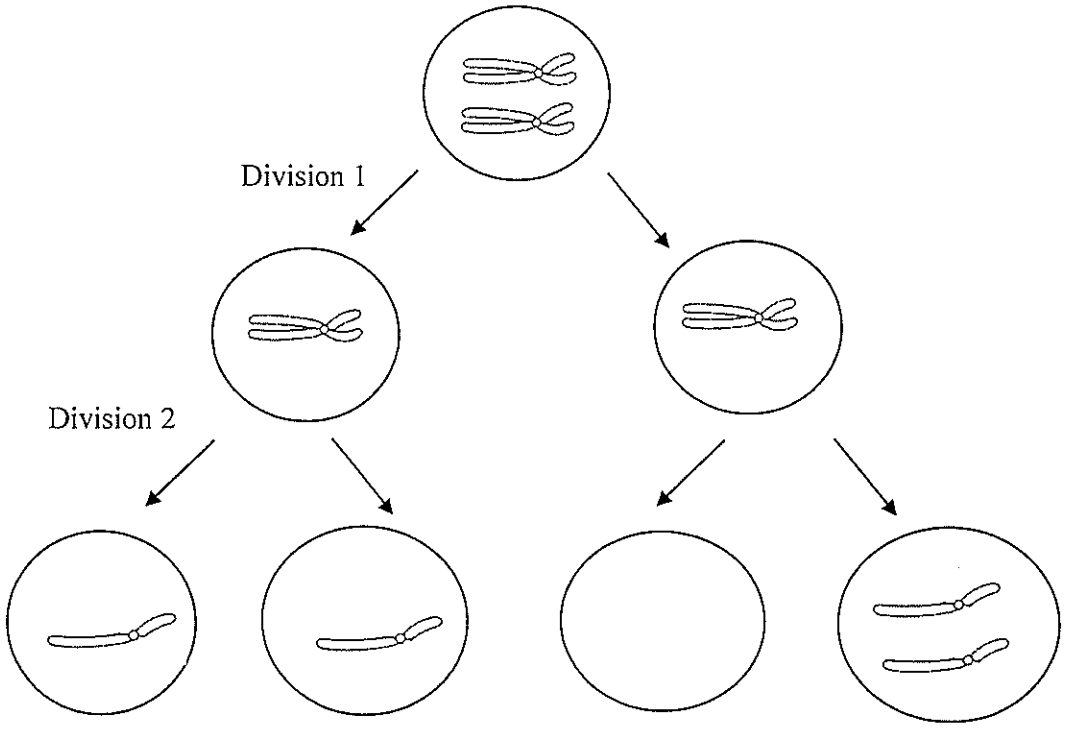

Figure 2

Continued...

b. An allele *Y* which controls the yellow coat color of mice is dominant over the allele *y* which controls the grey coat color. In a population of 2500 newborn mice, 400 are grey.
   i. Calculate the frequency of allele *Y*. (1½ marks)
   ii. Determine the number of individuals in a population of 2500 newborn mice who are expected to be heterozygous. (2 marks)

c. What is meant by *genetic drift*? (1½ marks)

d. **Figure 3** below shows a DNA sequence and two mutated DNA sequences, labeled **A** and **B**.
   i. Name the kind of mutation that happened in **A** and **B**. (1 mark)
   ii. Which mutation (**A** or **B**) is a frameshift mutation? (½ mark)
   iii. How many amino acids will be produced from sequence **B**? (½ mark)

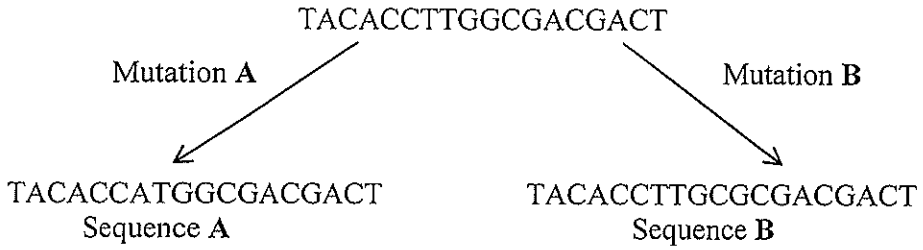

Figure 3

Continued...

Question 3 (10 marks)

a. The polymerase chain reaction (PCR) can be used to obtain many copies of a particular gene.
   i. Explain how the strands of DNA are separated during the PCR. (1 mark)
   ii. In a particular PCR, primers are added to the DNA. Why are primers required? (1½ marks)
   iii. Starting with a single molecule of DNA, the polymerase chain reaction was allowed to go through eight complete cycles. How many molecules of DNA would be produced? (½ mark)

b. **Figure 4** shows the process of a human gene being inserted into a plasmid.
   i. Name enzyme **X**. (½ mark)
   ii. Briefly explain the function of enzyme **X**. (1 mark)
   iii. Name the process of inserting structure **L** into the bacterium. (½ mark)
   iv. To get functional protein, the best technique to use is cDNA cloning. Explain how this technique works. (2½ marks)

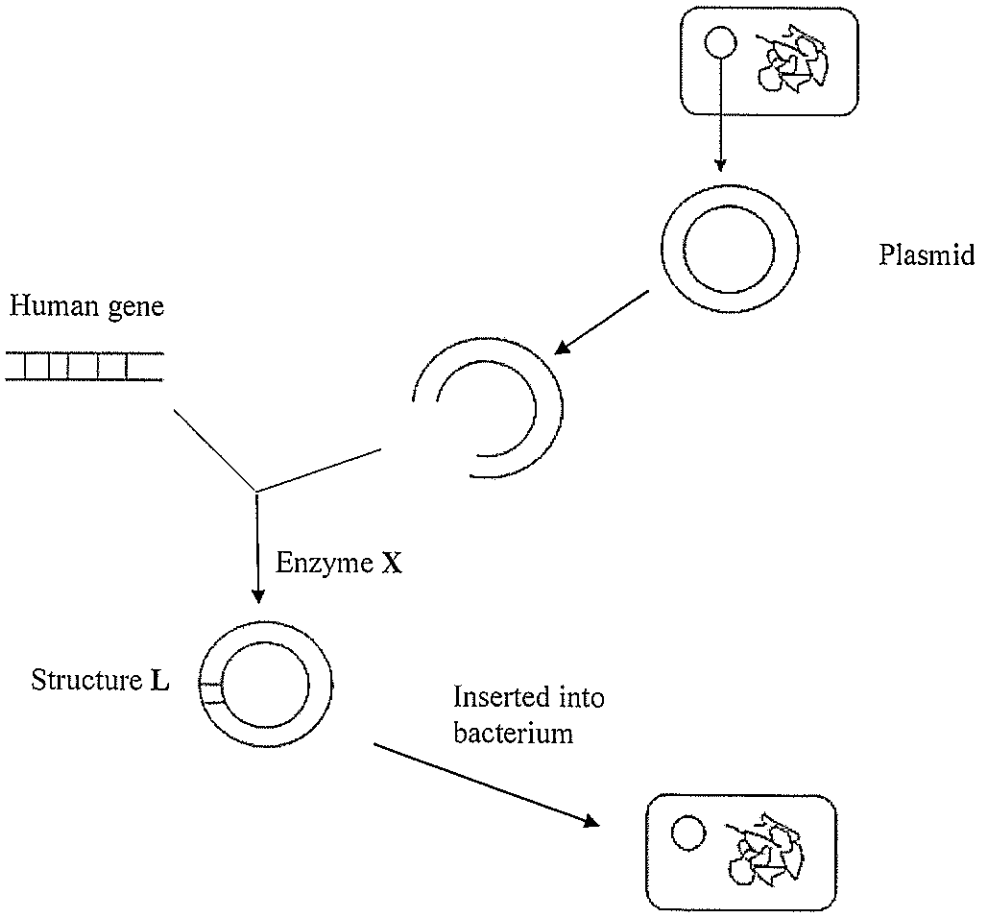

Figure 4

Continued...

c. There are many different kinds of restriction enzymes. **Figure 5** shows the position of four restriction sites **P**, **Q**, **R** and **S** for four different enzymes on a single plasmid. The distances between these sites are measured in kilobases(kb) of DNA. The plasmid was cut using only two restriction enzymes. The resulting fragments were separated by gel electrophoresis. The positions of the fragments after the gel electrophoresis are shown in **Figure 6**.

i. Determine the restriction sites that were cut. (½ mark)

ii. Explain the answer in c(i). (1 mark)

iii. How does gel electrophoresis work? (1 mark)

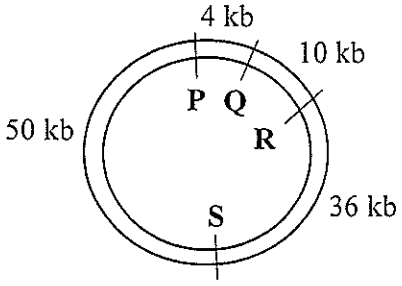

Figure 5

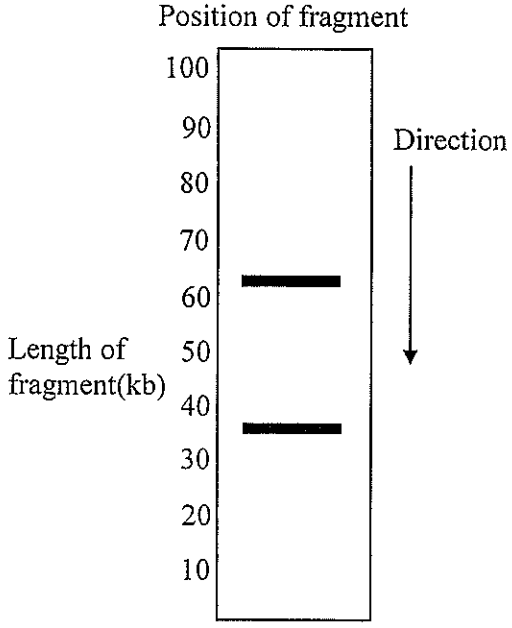

Figure 6

Continued...

Question 4 (10 marks)

a. The *EPAS*1 gene codes for a type of protein called a transcription factor, which helps to regulate the transcription of genes involved in red blood cell production. Some people have a mutated version of this gene that prevents the over-production of red blood cells.

i. Briefly explain the process of transcription. (2½ marks)

ii. Explain how a mutated version of the *EPAS*1 gene can cause a change in the transcription factor protein produced. (2½ marks)

b. DNA replication is an important event in the cell cycle. **Figure 7** shows pairing between two bases, **X** and **Y**, in a DNA molecule.

i. When does DNA replication occur during the cell cycle? (½ mark)

ii. Name the type of bond shown by the dotted lines between the bases in **Figure 7**. (½ mark)

iii. Which base, **X** or **Y**, is a pyrimidine? Explain your answer. (1 mark)

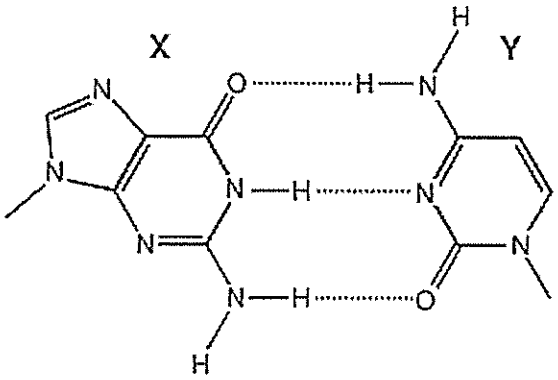

Figure 7

c. A piece of mRNA is 516 nucleotides long but the DNA coding strand from which it was transcribed is 726 nucleotides long.

i. What could be the reason for the difference in the number of nucleotides between the piece of mRNA and the coding strand? (½ mark)

ii. What is the maximum number of amino acids in the protein translated from this piece of mRNA? Explain your answer. (1 mark)

iii. Give three differences between the structure of mRNA and the structure of tRNA. (1½ marks)

Continued...

Question 5 (10 marks)

a. Insects need to go through metamorphosis during their growth and development.
   i. What is meant by the term metamorphosis? (1½ marks)
   ii. Briefly explain the importance of metamorphosis in the life of an insect. (2 marks)

b. Based on **Figure 8**, answer the following.
   i. Between which dates did menstruation take place? (½ mark)
   ii. What happened to the level of progesterone during menstruation? (½ mark)
   iii. On which date did ovulation take place? Explain the evidence for your answer. (1½ marks)
   iv. Explain why ovulation will not occur when a woman is pregnant. (2 marks)

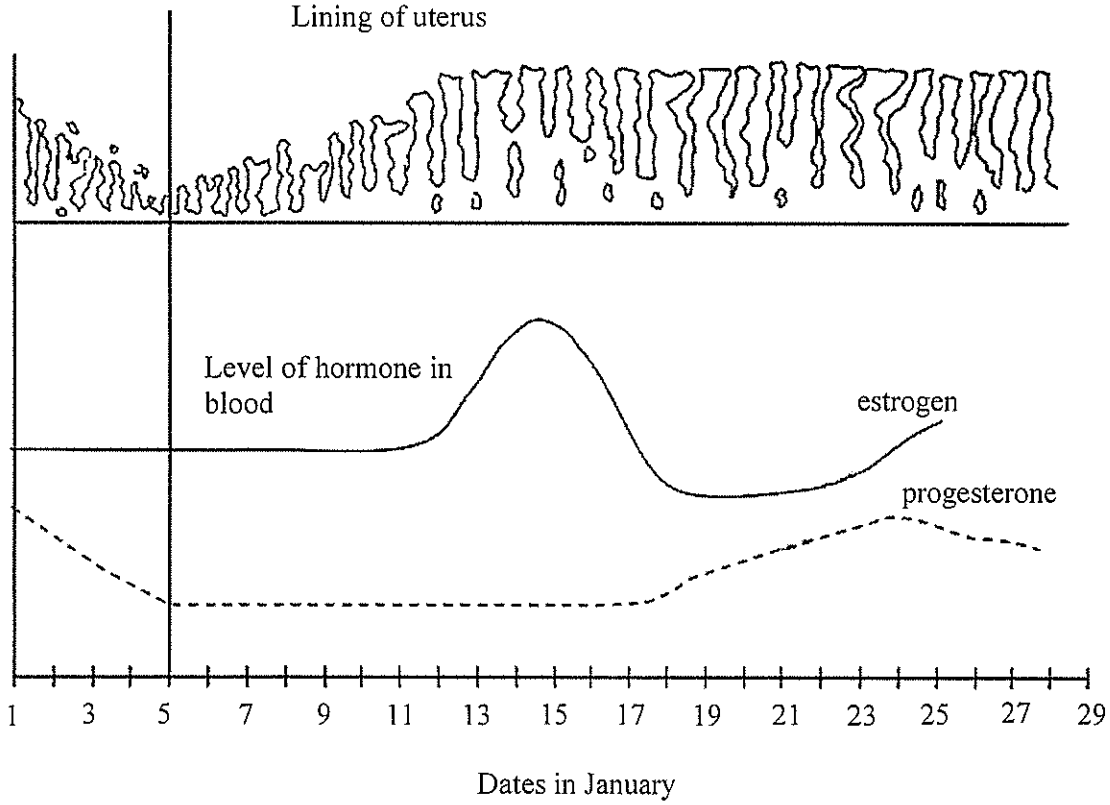

Figure 8

Continued...

c. **Figure 9** shows a longitudinal section of the root tip of a dicotyledonous plant.
   i. What is the function of the root cap? (½ mark)
   ii. Briefly describe the primary growth of the root. (1½ marks)

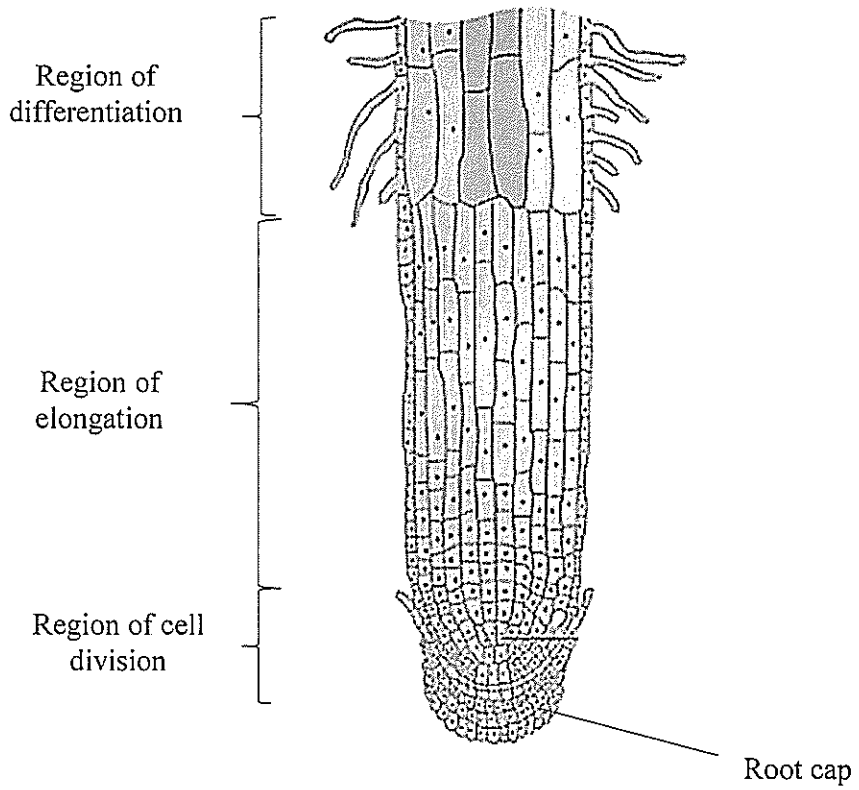

Figure 9

End of Paper